

REMARKS

Claims 8-16 are all the claims pending in the application. Claims 10 and 11 are rewritten in independent form to capture their allowable subject matter.

The drawings filed October 2, 2003 are objected to because the Examiner requests that FIG. 1 be designated with the legend --Prior Art--. Attached is a Replacement Figure 1 that includes this legend.

The Examiner requests that a translation of JP 5000-184614 be provided. A translation is hereby included for the Examiner's convenience.

Claims 8, 9, 12 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 2000-184614 (hereinafter "JP '614") in view of Muramatsu et al. (6,225,786 [hereinafter "Muramatsu"]). The rejection is respectfully traversed in view of the following remarks.

JP '614 is directed to an electrically powered tool which is powered by a DC power source or a battery pack. The battery pack is charged by the DC power source when the DC power source is not supplying power to the tool. The battery condition of the battery pack is only detected during charging of the battery pack, and this leads to many problems, e.g. the fully charged condition of the battery pack can't be detected immediately upon charging of the pack, and this delay may compromise the battery if it has been fully charged already. Thus, JP '614 does not continually detect the condition of the battery pack, including when the DC power source is currently supplying power to the tool. On the other hand, claims 8 and 9 describe that the detection continues when said battery pack is being currently charged or when said DC voltage from said DC power source is being supplied to said tool and charging of said battery pack is being interrupted.

More particularly, JP '614 discloses a cordless power tool 4 that is powered when a power switch 42 is ON, while a battery 5 is charged when the power switch 42 is OFF. JP '614 is provided with a battery-voltage detecting means 2A that detects the voltage of the battery 5. When the voltage detected by the battery-voltage detecting means 2A indicates the full charge condition of the battery 5, charging is stopped. When the power switch 42 is ON, that is, the cordless tool 4 is being driven, the battery-voltage detecting means 2A does not detect the voltage of the battery 5, so the full charge condition of the battery 5 is not determined.

Muramatsu charges first to tenth battery cells (block A) of a battery pack 50 and eleventh to 20th battery cells (block B) of the battery pack 50 in turns, and determines the completion of charge during charging. However, the completion of charge in the block B is not determined while the block A is being charged, or the completion of charge in the block A is not determined while the block B is being charged. In other word, Muramatsu determines the completion of charge on a block basis. This is apparent from S20 to S34 in Fig. 6 where the completion of charge is determined for either block A or B.

Although Muramatsu briefly describes how the battery is used in a tool (Fig. 3), this reference does not teach or suggest that the battery charger is connected to the tool. In fact, the charger 10 appears to be a completely separate entity from the tool. This reference is silent about determining the charge condition of the battery when the power tool is being operated. Thus, even if one were to combine the references one would not have been taught to monitor the battery charge condition when the power switch is turned on to supply DC voltage to the tool rather than to charge the battery.

Further, Applicants fail to see how the combination of references teaches or suggests the controller of claim 12 capable of receiving the condition signal from the battery condition means and determining that the battery is fully charged even if the charging means is not supplied with the DC power. There is no teaching in either reference that the fully charged status can be determined in this manner, when not supplied with the DC power. Thus, claim 12 should be patentable. Claim 13 which depends from claim 12 should be patentable for at least the same reasons by virtue of its dependency therefrom.

Accordingly, the invention of claims 8, 9, 12 and 13 would not be obvious from the teaching of JP '614 and Muramatsu. The rejection of claims 8, 9, 12 and 13 under 35 U.S.C. § 103(a) is therefore requested to be withdrawn.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

AMENDMENT UNDER 37 C.F.R. § 1.116
Appln. No.: 10/676,035

Attorney Docket No.: Q77756

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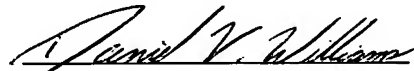
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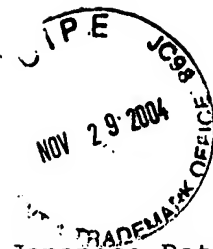
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AMENDMENTS TO THE DRAWINGS

Figure 1 is hereby amended to include the legend --Prior Art--. This change is believed to obviate the Examiner's objection in the Office Action dated July 29, 2004.

Attachment: Annotated Sheet
Replacement Sheet



Japanese Patent Application Laid-Open Publication 2000-184614

(Translation)

[Claims]

[Claim 1] A rechargeable DC power-supply apparatus which
5 comprises a cordless tool that has a power switch and is driven
by a removable battery, a DC power-supply apparatus main body that
converts an input AC current to a DC current, outputs a converted
current, and has a battery-insertion slot through which a battery
is inserted to be charged, and an adapter that has an insertion
10 part having the same shape as a battery receptacle of the tool and
is designed to supply an output of the main body to drive the cordless
tool, and in which the cordless tool is selectively driven by the
main body through the battery or the adaptor,

characterized in that switch-operation detecting means for
15 detecting whether the power switch is ON or OFF and switch-changeover
means for selectively supplying the output of the main body to the
adapter or the battery-insertion slot are provided in the main body,
the output of the main body is supplied to the battery-insertion
slot, thereby to charge the battery while the power switch remains
20 OFF, and the output of the main body is supplied to the adapter
while the power switch remains ON, thereby to driven the cordless
tool.

[Claim 2] The rechargeable DC power-supply apparatus according
to claim 1, characterized in that load-current detecting means is
25 provided to detect whether the main body is outputting a current
or not, and the output of the main body is supplied to the
battery-insertion slot through the switch-changeover means while

the power switch remains ON and the main body is not outputting a current.

[Detailed Description of the Invention]

[0001]

5 [Field of the Invention]

The present invention relates to a rechargeable DC power-supply apparatus for applying a DC voltage to a cordless tool having a removable battery used as power source, through an adapter removably connected to the cordless tool, thereby to recharge the battery
10 provided in the cordless tool.

[0002]

[Prior Art]

Cordless tools are advantageous in that they can be used in any place, not bothered with power-supply cables. However, they
15 are disadvantageous in that the battery must be recharged or replaced by a new one when the power in the battery decreases to some extent. If a cordless tool is used in a place near an AC power supply and is moved only a few times while being used, a DC power supply is used, which can convert the AC current to a DC current. If the
20 cordless tool is used in a place far from an AC power supply and frequently moved while being used, a rechargeable battery is used. That is, the battery and the DC power supply are interchangeably employed in accordance with the manner in which the cordless tool is used.

25 [0003]

Here arises a problem, however. The cordless tool cannot be efficiently used unless a charger and a DC power supply are

available at the place where the cordless tool is used. To solve this problem, a rechargeable DC power-supply apparatus has been proposed in, for example, Jpn. Pat. Appln. Laid-Open Publication No. 2-65630 and Jpn. Pat. Appln. Laid-Open Publication No. 5-56566.

5 This apparatus simultaneously recharges the battery and drives the cordless tool as long as the power switch of the tool remains ON. When the power switch is OFF, the apparatus only recharges the battery.

[0004]

10 [Objects of the Invention]

The rechargeable battery for use in cordless tools has a storage capacity of 1.2 to 2.0 Ah. To recharge the battery within 30 minutes, 15 minutes and 10 minutes, the recharging current must be increased to 2.4 to 4.0 A, 4.8 to 8.0 A, and 7.2 to 12.0 A, respectively. Cordless tools are driven, usually at a current ranging from 10 A to 40A, depending on the types of the tools. To recharge the battery in a cordless tool, while using the tool, the DC power supply must be increased. Consequently, the DC power-supply apparatus will become heavier and larger. To avoid this consequence, 20 the cordless tool may be driven while the power switch remains ON, and the battery is recharged while the power switch remains OFF. This method is employed in some types of shavers. The method is useful to tools, such as shavers, in which the DC power supply, power switch, battery and motor are provided in one case. The method 25 is not useful to any rechargeable DC power-supply apparatus that applies a DC voltage to a cordless tool having a removable battery used as power source, through an adapter removably connected to

the cordless tool. Since the power switch is incorporated in the cordless tool, more cables must be used to connect the tool to the DC power-supply apparatus if the battery is recharged at the DC power-supply apparatus while the power switch remains OFF. The
5 cables are heavy, making it difficult to use the cordless tool. Further, a power loss occurs during the recharging of the battery, ultimately wasting energy.

[0005]

An object of this invention is to solve the above-mentioned
10 problem with the prior art, thereby to drive a cordless tool and recharge the battery in the tool, without increasing the weight and size of the DC power supply and without increasing the number of cables, each having an adapter that can be removably connected to the cordless tool.

15 [0006]

[Means for Achieving the Object]

To achieve the above-mentioned object of the invention, it is detected, at the DC power-supply apparatus, whether the cordless tool is driven or not. While the cordless tool is being driven,
20 the battery is not recharged. The battery is charged while the cordless tool remains stopped.

[0007]

[Embodiment of the Invention]

An embodiment of this invention will be described, with
25 reference to the accompanying drawings. As shown in FIG. 3, a rechargeable DC power-supply apparatus includes a cord set 1, a main body 2, and a cable set 3. The cord set 1 includes an input

cable 12 having a plug 11 at one end. The plug 11 can be connected to the commercially available AC power supply. As FIG. 1 shows, the main body 2 includes a rectifying/smoothing means 21, a DC-DC converter 22 (hereinafter referred to as "converter"), a

5 load-current detecting means 23, a switch-operation detecting means 24, a switch-changeover means 25, a charge-current control means 26, a supply voltage detecting means 27, a voltage-drop correcting means 28, a drive-voltage control means 29, a battery-voltage detecting means 2A, a converter operation control means 2B, and

10 a single-chip microcomputer 2C (hereinafter referred to as "micom"). The rectifying/smoothing means 21 rectifies and smoothens the current supplied from the commercially available AC power supply. The load-current detecting means 23 detects the current flowing through the motor 41 of a cordless tool 4 or the current flowing

15 in a battery 5. The switch-operation detecting means 24 detects whether the power switch 42 is ON or OFF. The switch-changeover means 25 determines whether the power switch 42 is ON or OFF, thus detecting whether the cordless tool 4 is operating. When the power switch 42 is found to be OFF, the battery 5 is charged. When the

20 power switch 42 is ON, the charging of the battery 5 is stopped, and power is supplied to the cordless tool 4 only. The charge-current control means 26 controls the switching duty of the converter 22 in accordance with a signal supplied from the load-current detecting means 23 when the power switch 42 is turned OFF. Thus, the means

25 26 maintains the charge current of the battery 5 at a constant value. The supply voltage detecting means 27 detects the voltage output from the converter 22. The voltage-drop correcting means 28

generates a signal from a signal supplied from the load-current detecting means 23. The signal generated by the means 28 will correct the voltage drop across the cable set 3. The drive-voltage control means 29 controls the switching duty of the converter 22 while the power switch 42 remains ON, in accordance with the signals supplied from the supply voltage detecting means 27 and signal generated by the voltage-drop correcting means 28. The means 29 can therefore supply a constant voltage to the motor 41. The battery-voltage detecting means 2A detects the battery voltage, i.e., the output voltage of the battery 5. The converter operation control means 2B controls the ON-OFF operation on the converter 22. The micom 2C controls the switch-changeover means 25 and the converter operation control means 2B in accordance with the signals supplied from the load-current detecting means 23 and switch-operation detecting means 24. The micom 2C determines whether the battery 5 is fully charged, on the basis of the signal supplied from the battery-voltage detecting means 2A, and then controls the converter operation control means 2B. The main body 2 has a slot 2E, through which the battery 5 can be inserted into the main body 2.

[0008]

As FIG. 2 depicts, the switch-operation detecting means 24 includes diodes 241 to 243, resistors 244 and 245, and a comparator 246. The means 24 detects that the power switch 42 is turned ON, if the switch 252 of the switch-changeover means 25 connects the output terminal of the converter 22 to the battery 5. More precisely, voltage V_{ref1} is applied to the comparator 246 via the diode 241 and resistors 244 and 245 while the power switch 42 remains OFF.

The comparator 246 therefore outputs a logic value "1." Voltage Vref1 is higher than voltage Vref2, or $V_{ref1} > V_{ref2}$. While the power switch 42 remains ON, the comparator 246 receives a voltage that has been obtained by dividing the voltage Vref1 by the diode 241, resistor 244, power switch 42 and the DC resistance of the motor 41. The DC resistance of the motor 41 is much lower than the resistance of the resistor 244 (it is only a few ohms). Hence, the voltage applied to the comparator 246 is almost 0 V. As a result, the output of the comparator 246 has logic value "0." From the output of the comparator 246, it is therefore determined that the power switch 42 has been turned ON. When the power switch 42 is found to be ON, the switch 252 connects the output of the converter 22 to the cordless tool 4. In this condition, the load-current detecting means 23 detects whether the power switch 42 is OFF or not. That is, the means 23 detects that the power switch 42 has been turned OFF, if the current is zero.

[0009]

The switch-changeover means 25 includes a changeover- signal generating means 251 and switches 252 and 253. The changeover- signal generating means 251 is, for example, an electromagnetic relay coil. As known in the art, the microcomputer 2C has an MCU, or arithmetic operation unit, a ROM and RAM, both provided in the memory unit, a timer unit, an A/D converter provided in an input/output unit, an input port, an output port and the like.

[0010]

The cable set 3 includes an output cable 33 that has an adapter plug 31 at one end, and a connector 32 at the other end. The adapter

plug 31 is connected to the cordless tool 4. The connector 32 is connected to the main body 2. The upper part of the adapter plug 31 has the same shape as the receptacle made in the battery 5 and can be removably coupled to the cordless tool 4.

5 [0011]

How the apparatus according to this invention operates will be explained. When the plug 11 of the cord set 1 is connected to the commercially available AC power supply, the converter operation control means 2B generates an OFF signal, which turns the converter
10 22 off (Step 101). The switch-changeover means 25 connects the switch 252 to the battery 5 and the switch 253 to the charge-current control means 26 (Step 102). Initial setting is performed, resetting the charging-completion flag stored in the RAM area of the micom 2C (Step 103). Then, whether the power switch 42 is ON or OFF is
15 determined from the signal supplied from the switch-operation detecting means 24 (Step 104). If the power switch 42 is off, it is determined whether the battery 5 is inserted into the slot 2E of the main body 2 (Step 105). If the battery 5 is not inserted, the operation returns to Step 104.

20 [0012]

If the battery 5 is inserted (if the apparatus is in the charging mode), it is determined whether the charging-completion flag is reset in the RAM area of the micom 2C (Step 111). If the charging-completion flag is not reset, it is determined that the
25 battery 5 has been fully charged. In this case, the battery 5 is not further charged, and the operation goes to Step 116. If the charging-completion flag is reset, the converter operation control

means 2B generates an ON-signal, which turns the converter 22 on. The charging of the battery 5 is thereby started (Step 112). The battery is charged with a constant charge current that is controlled by means of the method known in the art. That is, the signal generated by the load-current detecting means 23 is fed back to the charge-current control means 26. The load current is compared with the charge current set in the charge-current control means 26 and is amplified. The output of the control means 26 is supplied to the converter means 22, thereby maintaining the charge current at a constant value. More specifically, the duty ratio of the PWN control being performed by the converter means 22 is increased if the charge current flowing in the battery 5 is smaller than a preset charging current value. If the charge current flowing in the battery 5 is larger than the preset charging current value, the duty ratio of the PWN control is decreased. In either case, the charge current is maintained at a constant value.

[0013]

Next, the battery-voltage detecting means 2A detects the battery voltage, thereby to determine whether the battery 5 has been fully charged (Step 113). That is, a signal representing the battery voltage detected is supplied to the micom 2C through the battery-voltage detecting means 2A. The detection may be peak-value detection, $-\Delta V$ detection, or the like. As known in the art, the full charging can be detected by methods other than the detection of the battery current. It can be detected from the temperature of the battery, the battery voltage, or both. One of these methods can be selected and used to determine whether the battery 5 has

been fully charged.

[0014]

When the full charging is detected, the converter operation control means 2B generates an OFF-signal, which turns the converter
5 22 off. The charging of the battery 5 is thereby stopped (Step 114). The charging-completion flag is set in the RAM area of the micom 2C (Step 115). The flag thus set indicates that the battery 5 has been fully charged. Then, it is determined whether the battery 5 has been removed from the main body 2 (Step 116). If the battery
10 5 has been removed, the charging-completion flag is reset (Step 117), and the operation returns to Step 104. If the battery 5 remains inserted in the main body, it is determined whether the power switch 42 is ON or OFF (Step 118). If the power switch 42 is OFF, the operation returns to Step 116. If the power switch 42 is ON, the
15 operation goes to Step 131.

[0015]

If it is determined in Step 113 that the battery has not been fully charged, it is determined whether the battery 5 is inserted in the main body 2 (Step 119). If the battery 5 has been removed,
20 the converter operation control means 2B generates an OFF-signal, which turns the converter 22 off (Step 120). The operation then returns to Step 104. If the battery 5 is inserted in the main body 2, it is determined whether the power switch 42 is ON or OFF (Step 121). If the power switch 42 is OFF, the operation returns to Step 113. If the power switch 42 is ON, the operation goes to Step 131.

[0016]

If the power switch 42 is found to be ON, in Step 104 (if

the apparatus is in the mode of driving the cordless tool), the converter operation control means 2B generates an OFF-signal, which turns the converter 22 off (Step 131). In this case, the switch 252 is connected to the cordless tool 4, and the switch 253 is connected to the drive-voltage control means 29 (Step 132). When the converter operation control means 2B generates an ON-signal, this signal turns the converter 22 on (Step 133). Then, it is determined whether the load current is zero, in order to determine whether the power switch 42 has been turned OFF (Step 134). If the load current is zero, the converter operation control means 2B generates an OFF-signal, which turns the converter 22 off (Step 135). The switch 252 is connected to the battery 5, and the switch 253 is connected to the charge-current control means 26 (Step 136). The operation then returns to Step 104. If the load current is not zero, it is determined whether the battery 5 has been removed from the main body 2 (Step 137). If the battery 5 is found to have been removed, the charging-completion flag is reset (Step 138). The operation returns to Step 134. If the battery 5 is not found to have been removed, the operation returns to Step 134.

20 [0017]

Assume that neither Step 137 nor Step 138 is performed. Then, the apparatus is set to mode of driving the cordless tool when the battery 5 fully charged in the charging mode is inserted into the main body 2. If the apparatus is set to the charging mode after the battery 5 is removed in the mode of driving the cordless tool, the charging will not start because the charging-completion flag remains set even if the battery 5 is inserted. To solve this problem,

Steps 137 and 138 are carried out.

[0018]

[Advantages of the Invention]

In the present invention, the charging of the battery is
5 stopped by all means while the cordless tool is being driven. Hence,
the DC power supply can supply its maximum current to the cordless
tool. While the cordless tool remains not driven, the battery can
be charged within a short time. Since the cordless tool is driven
at a time and the battery is charged at another time, it is possible
10 to charge the battery, without applying any stress to the battery
whose voltage differs from the voltage for driving the cordless
tool.

[Brief Description of the Drawings]

[FIG. 1] A block diagram showing a rechargeable DC power- supply
15 apparatus that is an embodiment of the present invention.

[FIG. 2] A circuit diagram illustrating an embodiment of a
switch-operation detecting means that may be used in this invention.

[FIG. 3] A perspective view depicting an embodiment of the
invention.

20 [FIG. 4] A flowchart explaining an embodiment of the present
invention.

[Explanation of Reference Numerals]

21 denotes a rectifying/smoothing means, 22 denotes a DC-DC
converter; 23 indicates a load-current detecting means; 24 denotes
25 a switch-operation detecting means; 25 designates a
switch-changeover means; 2C indicates a micom; 4 denotes a cordless
tool; 41 indicates a motor; 42 designates a power switch; 5 indicates

a battery.

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FIG. 1

OUTPUT PORT
A/D INPUT PORT
5 OUTPUT PORT
A/D INPUT PORT
INOUT PORT

FIG. 2

TO MICOM

10 FIG. 4

START
101. TURN OFF DC-DC CONVERTER
102. CONNECT THE SWITCH-CHANGEOVER MEANS TO THE BATTERY
103. RESET THE CHARGING-COMPLETION FLAG
15 104. POWER SWITCH ON?
105. BATTERY INSERTED?
(CHARGING MODE)
111. CHARGING-COMPLETION FLAG RESET?
112. START CHARGING, AND TURN DC-DC CONVERTER ON
20 113. BATTERY FULLY CHARGED?
114. CHARGING COMPLETE, AND TURN DC-DC CONVERTER OFF
115. SET THE CHARGING-COMPLETION FLAG
116. BATTERY INSERTED?
117. RESET THE CHARGING-COMPLETION FLAG
25 118. POWER SWITCH ON?
119. BATTERY INSERTED?
120. TURN DC-DC CONVERTER OFF

- 121. POWER SWITCH ON?
(MODE OF DRIVING THE CORDLESS TOOL)
- 131. TURN DC-DC CONVERTER OFF
- 132. CONNECT THE SWITCH-CHANGEOVER MEANS TO THE LOAD
- 5 133. TURN DC-DC CONVERTER ON
- 134. LOAD CURRENT ZERO?
- 135. TURN DC-DC CONVERTER OFF
- 136. CONNECT THE SWITCH-CHANGEOVER MEANS TO THE BATTERY
- 137. BATTERY INSERTED?
- 10 138. RESET THE CHARGING-COMPLETION FLAG